A NEW LOUISIANA COPEPOD RELATED TO *DIAPTOMUS* (*AGLAODIAPTOMUS*) *CLAVIPES* SCHACHT (COPEPODA, CALANOIDA)

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Study of new collections from small bodies of fresh water in Louisiana continues to reveal species of copepods new to science as well as species as yet unrecorded for the state. The present report describes the fourth new Louisiana species to be added recently to the list of North American diaptomid copepods. Others are *Diaptomus louisianensis* M. S. Wilson and Moore (1953a), *D. bogalusensis* M. S. Wilson and Moore (1953b) and *D. moorei* M. S. Wilson (1954).

It is also of interest to note that the type localities of two other diaptomid copepods are in Louisiana. Of these, *D. conipedatus* Marsh (1907) has not yet been reported from outside the state. *D. dorsalis* Marsh (1907) is now known to be fairly common in the southeastern states and also to occur in the West Indies. Kiefer (1936) recorded it from Haiti as a new species, *D. proximus*. Kiefer's description is more detailed than that of Marsh and comparison of it with type material of *dorsalis* in the United States National Museum shows that differences noted by Kiefer were omitted from the original description. The species also occurs in Puerto Rico having been identified by myself in a U. S. National Museum collection from Guanica Lake. *D. dampfi* Brehm (1932, 1939) from Lake Peten, Guatemala, is closely allied to *dorsalis* and may or may not be synonymous. Brehm's descriptions are too incomplete to allow for a satisfactory decision on the basis of his papers alone.

The occurrence of *dorsalis* throughout the southeastern United States and the West Indies, and its possible presence in Central America, suggests that these new species should be looked for throughout this relatively little known area. Neither the recently discovered species nor the older *conipedatus* should be considered endemic to Louisiana on the basis of present knowledge. Although there may well be extreme localization of some species in the southeastern part of the continent, recent studies have extended the range of species that for many years were considered localized or rare, and no conclusions should be drawn until an intensive survey of the region has been made. One of the new species (*moorei*) is already known from eastern Texas.

Anyone studying Louisiana diaptomids, should also note the new species recently found in neighboring areas: *D. sinuatus* Kincaid (1953), a form closely allied to *bogalusensis*, from Panama City, Florida; *D. marshianus* M. S. Wilson (1953) from Lake Jackson, Florida; and *D. texensis* M. S. Wilson (1953) from Aransas County, Texas.

Kiefer (1936: 309) summarized the literature dealing with the

free-living fresh and brackish water copepods of this region (West Indies, Florida west to Texas, Mexico and Central America). Since then, records of distribution of such copepods in this general region are found in papers by C. B. Wilson (1936, 1938), Kiefer (1938), Pearse (1938), Brehm (1939), Harkness and Pierce (1940), Osorio Tafall (1941, 1942a, b, 1943), Coker (1943), Yeatman (1944), Penn (1947), Pierce (1947), Davis (1948), Dickinson (1949), King (1950), Davis and Williams (1950), Comita (1951), Hoffman and Causey (1952), Kincaid (1953), Peckham and Dineen (1953), M. S. Wilson (1941, 1953, 1954) and M. S. Wilson and Moore (1953a, b).

I am indebted to Dr. James E. Sublette of Northwestern State College, Natchitoches, Louisiana, who made the collections of the new species upon which this study is based, and to Dr. Walter G. Moore of Loyola University who referred the collections to me. Specimens of *Diaptomus clavipes* Schacht used for comparative study were from the collections of the United States National Museum and the Illinois Natural History Survey.

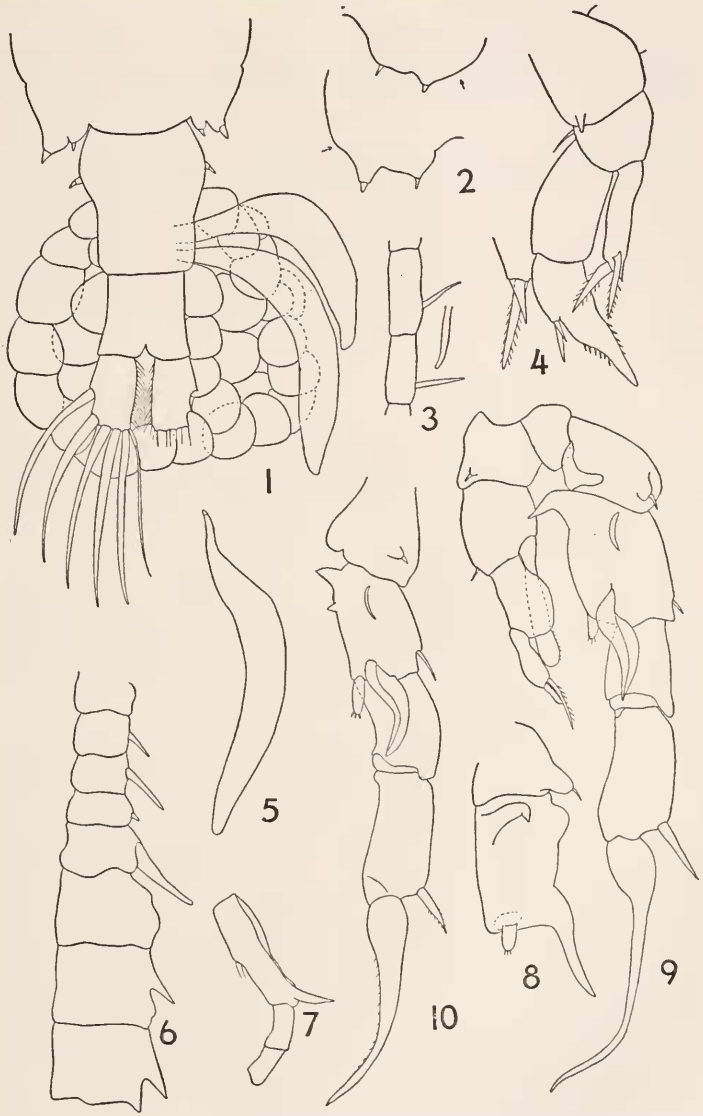
DIAPTOMUS (AGLAODIAPTOMUS) CLAVIPOIDES, sp. nov.

Specimens Examined.—Type lot: five hundred adults of both sexes, many females ovigerous and with attached spermatophores; seasonal pond near Grand Ecore, Natchitoches Parish, Louisiana, March 23, 1954, J. E. Sublette. Associated with *D. moorei* M. S. Wilson. Holotype ♀, United States National Museum catalog number 97230, allotype ♂, number 97231.

One hundred adults of both sexes, same locality, May 31, 1954.

Diagnosis.—With these characters of the subgenus *Aglaodiaptomus:* Two setae on segment 11 of female and left male antennules. Right antennule male, segment 14 without spinous process but with processes on segments 15 and 16. Maxilliped with three setae on distal lobe of basal segment. Leg 2, Schmeil's organ present on endopod segment 2 of both sexes. Leg 5 of female, third segment of exopod imperfectly separated; two well developed, thickly plumose setae on apex of endopod. Leg 5 of male, left exopod of the *leptopus* form with narrow distal segment and closely set, apical processes; the outer process digitiform, the inner a much longer curving seta.

Length, ♀ 2.3-2.5 mm. ♂ 2.0-2.13 mm. Greatest width of metasome in both sexes in mandibular area of cephalic segment. Metasome segments 5 and 6 separated only by short lateral suture. Metasomal wings of female not laterally expanded and with slight asymmetry; each wing with moderately developed inner lobe not reaching beyond that of the outer portion, that of the left a little larger than that of the right (fig. 2); in dorsal view, this difference is hardly noticeable (fig. 1). Urosome of female two-segmented (fig. 1); genital segment with very slight lateral symmetrical swelling; caudal rami shorter than anal segment (segments 2 + 3), hairs on inner margin only. Ova numerous, average number per ovisac 26. Urosome of male symmetrical except for backwardly produced portion



Figures 1-9. *Diaptomus clavipoides*, sp. nov., female: **1.** metasomal segments 5-6 and urosome, dorsal view, ovigerous specimen with two attached spermatophores; **2.** right (top) and left metasomal wings, lateral view (arrows indicate outer edge); **3.** setae of antennule segments 19-20, with detail of apex; **4.** leg 5, with detail exopod setae. Male: **5.** spermatophore, dissected out from body; **6.** right antennule, spines and processes of segments 10-16; **7.** same, apical segments 23-25; **8.** leg 5, right basipod 2, profile view of processes of mid-posterior face; **9.** leg 5, posterior view.
Figure 10. *Diaptomus clavipes* Schacht: male, right leg 5, posterior view (from slide in type lot, Illinois Natural History Survey collection.)

of right side of segment 4. Spermatophore somewhat angled near its proximal third and curved in the midportion (fig. 5); when attached to the female and viewed dorsally, it appears strongly curved to the right (fig. 1).

Antennules of both sexes reaching to near middle of urosome; those of the female and left side of the male with two setae on segment 11, and one on segments 13-19; setae of segments 17, 19, 20 and 22 shorter than the length of their segments, stiff, their tips not bent into a hook, though sometimes slightly curved (fig. 3). Right antennule of male (fig. 6) with spine of segment 8 not enlarged, that of 13 longer than that of 11, outcurved. Proportions of spines to the segmental width and to one another:

Segment	10	11	13
Segment width	23	23	35
Spine length	16	25	33

Strong spinous processes at midpoint of segments 15 and 16. Segment 23 (fig. 7) with short (length subequal to segment width), thick process strongly directed outward; a hyaline membrane along entire margin of segment to base of process.

Leg 5, female (fig. 4). Exopod 3 not developed. Lateral seta of segment 2 lacking. Outer seta of exopod 3 a stout, flat spine; the inner a plumose seta at least twice the length of the outer. Endopod reaching to end of first exopod segment or beyond; the terminal setae with widened bases and thickly plumose margins, their length about half that of the endopod.

Leg 5, male (fig. 9). Left leg reaching from just above middle of right exopod 2 to a little beyond. Basal sensilla of both legs short, slender spines. Midposterior face of right basipod 2 (fig. 8), with a proximal rounded lobe and a large distally placed process which reaches to near the end of the first exopod segment and consists of a curved spinous portion and an inner membrane; proximally the inner margin of the segment is produced into a prominent process bent at its middle into an obliquely directed spiniform portion. Relative proportions of outer margins of right basipod 2 and exopod segments 1 and 2, 39:32:45. Lateral spine of right exopod 2 placed near distal end, its length a little less than width of segment, 20:23. Claw longer than exopod, 85:77, enlarged basally, tapered abruptly beyond basal swelling so that it is very slender throughout, the tip usually recurved. Left basipod and exopod subequal to one another. Relative lengths of outer margins of exopods 1 and 2, 20:22. Left exopod 1 swollen medially, with extensive hairy pad. Left exopod 2 comparatively much reduced in width, its length about three times its width; processes terminally placed close together, the inner seta at least twice the length of the outer digitiform process, about 20:9. Right endopod reduced, reaching to proximal fourth or third of exopod 1. Left endopod elongate, reaching beyond middle of exopod 2.

Systematic Discussion

This new species is closely allied to *Diaptomus clavipes* Schacht (1897). The following notes comparing the characters of the two species are based upon study of a large number of specimens of both. Several collections of *clavipes* have been examined. Most of these are listed under the section "Distribution" as new records. In addition, some slides from the type lot in the Schacht collection, Illinois Natural History Survey have been studied, as well as whole specimens of *D. nebraskensis* Brewer (1898) from the type lot in the U. S. National Museum. As has been long recognized, Brewer's name is synonymous with *clavipes.*

Relationship of the two species is shown by both sexes. They do not vary widely from one another in total length range, and both have stout bodies and appendages. The females are very similar to one another, but exhibit several constant differences which are considered to be of specific value in these as well as in other diaptomids. In both species, the urosome is two-segmented and the genital segment is without noticeable lateral protrusions. Their differences are:

(1) *Metasome:* greatest width in the mandibular area of the cephalic segment in *clavipoides;* in the second segment in *clavipes.*

(2) *Metasomal wings:* with moderately developed inner lobes and of nearly same size in *clavipoides;* lacking inner lobes in *clavipes* and with the left wing more produced posteriorly than the right.

(3) *Antennule:* setae of segments 17, 19, 20 and 22 with unhooked ends in *clavipoides;* with hooked ends in *clavipes.*

(4) *Leg 5:* lateral seta of exopod 2 lacking in *clavipoides;* present in *clavipes.*

The structure of the fifth leg in the male is quite indicative of the close relationship of the two species. Each has on the posterior medial face of the right second basipod segment a proximal lobe and a large distal process. Comparable armature is found in other aglaodiaptomids (*leptopus, spatulocrenatus, conipedatus*) but the distal process is much smaller in them. *D. clavipes* and *clavipoides* are further distinguished from these species by the presence of the mesially directed process on the inner basal portion of this segment. It is in the same position in the two species, but differs in size and shape. In *clavipes,* it is comparatively small (its width about 13-15 percent of the length of the inner margin of the segment) and protrudes directly outward from the segment. In *clavipoides,* there is a stout basal portion with a nearly equally large, obliquely directed spiniform apex; its width is about 24-25 percent of the total length of the inner margin of the segment. In *clavipes* there is also a smaller process placed distad to the basal process near the middle of the segment (fig. 10). This second process is lacking in *clavipoides.* Other noticeable differences are the more reduced right endopod of *clavipoides,* and the greater length of the claw. In *clavipes,* the endopod

usually reaches to near the middle of the first segment of the exopod, and the claw is shorter than the exopod.

The left antennule of the male of *clavipoides* agrees with those of the female in having straight setae on segments 17, 19, 20 and 22; these were hooked in all the various collections of *clavipes* that were examined. The right antennule in these two species is similar in the armature and relative lengths of the spines of segments 8-16. The apical process of segment 23 was invariably present in the numerous specimens of *clavipoides,* all of which were checked for this character, but it was not found in specimens of *clavipes,* nor has it been recorded in literature for this species. In both, there is a lateral hyaline membrane along the entire margin of the segment; in *clavipes,* this membrane is very strongly developed with a well rounded apex.

The spermatophores attached to the female genital segment and also some dissected out from the body of the male, were bent near the base and curved as shown in figures 1 and 5. In the specimens of *clavipes* that were examined, the spermatophore is nearly straight and unangled as is usual in *Diaptomus.* What significance, if any, attaches to this unusual shape in *clavipoides,* is not known. On the basis of the type lot it is a character of distinction from *clavipes* and one that should be carefully checked in future studies of the species and other aglaodiaptomids.

The differences between the males of the two species may be summarized as follows:

(1) *Leg 5, right:* Second basipod segment, inner proximal process with enlarged basal portion and obliquely directed apex in *clavipoides;* without enlarged basal portion and the apex directed mesially in *clavipes;* no small process distad to proximal process in *clavipoides,* present in *clavipes.* Claw longer than exopod in *clavipoides;* shorter than exopod in *clavipes.* Endopod short in *clavipoides* (about one-fourth to one-third of length of inner margin of exopod 1); longer in *clavipes* (nearly one-half of exopod 1).

(2) *Antennule:* Left, setae of segments 17, 19, 20 and 22 with straight end in *clavipoides;* with hooked end in *clavipes.* Right, segment 23 produced into outwardly directed process and with lengthwise membrane in *clavipoides;* with membrane only in *clavipes.*

(3) *Spermatophore:* bent near base and curved in *clavipoides;* without such distinct curvature in *clavipes.*

Because of the seemingly close relationship of the new species to *clavipes,* particular attention was paid in study of specimens to the possible existence of variation in the characters by which the two forms are separated. Dissections of twenty specimens of both sexes of *clavipoides,* and of the same number of *clavipes* from a single sample (Baja California) were checked for variation in the stated diagnostic differences in the antennules and the fifth legs. In addition, these were further checked on two to five specimens of *clavipes* from each of the new collection records listed herein. No variation

was found in either species in any of the "present-absent" characters such as the lateral seta of the second exopod segment of the female fifth leg, the apical hook on certain antennular setae, the process of segment 23 of the male right antennule, and the small medial process of the right second basipod segment of the male fifth leg. In the "quantitative" characters such as the comparative size of the proximal process of the inner margin of the second basipod segment, the claw and endopod of the male right fifth leg no intermediate condition or overlap was found. Those characters for which dissection was unnecessary for observation, such as the attached spermatophore, the shape of metasome and wings, the apex of the antennular setae and the process of segment 23 of the male right antennule, were also checked on all the available whole specimens and no variation found.

Some of the structural characters of *clavipoides* are of considerable taxonomic interest. Among these is the lack of development of the third exopod segment and the absence of the lateral seta of the second exopod segment of the female fifth leg.

From species to species and also within individual species in the subgenus *Aglaodiaptomus,* there is considerable variation in the degree of development and the distinctness of separation of the third segment, but *clavipoides* is the only species in which I have observed the apparently constant combination of complete loss of both the third segment and the seta of the second segment. This is a distinctive character of three related North American subgenera, *Leptodiaptomus, Onychodiaptomus* and *Skistodiaptomus.* Between these subgenera and the common western and northern subgenus *Hesperodiaptomus,* the aglaodiaptomids are an intermediate group. This intermediate position is well emphasized in *clavipoides* in the reduction in the exopod of the female fifth leg.

The straight tips of the setae on certain segments of the female antennules and on the left antennule of the male in *clavipoides* have been particularly noted because in most of the species of the subgenus *Aglaodiaptomus* these setae have a characteristic hooked tip. Although small, this hook is distinct enough to be noticeable in undissected specimens under low power of the microscope. The variability of such a character might be questioned, but I have never found the hook lacking in large numbers of specimens of all the species concerned from a wide geographical range. The only species of the subgenus other than *clavipoides* in which this hook is not present is *D. stagnalis,* which also differs in several other details from the conditions usual in other aglaodiaptomids and has no near relative among the known species.

Most of the species of the subgenus *Aglaodiaptomus* have only 1 seta on each of segments 13-19. Those in which 2 setae are found on some segments are *stagnalis* (2 on 14, 16, 18, 19) and *lintoni* and *forbesi* (2 on 16). Occasionally, in this group as in other diaptomids having two setae on segment 11, an extra seta may be present on a segment which normally has only one. I have never observed in the

female such a seta on both antennules of a pair. This asymmetry coupled with the comparative rarity, makes this condition appear as an anomaly comparable to the occasional multiplication of other setae, claws or structures that have been noted in several appendages in all diaptomid groups. Among a large number (117) of female *clavipoides* carefully checked for antennal setation, two instances of such anomaly were found. One individual had two setae on segment 13 of the right antennule, another had two on segment 19 of the left; in each instance the corresponding segment of the opposite antennule was normal.

Distribution

D. clavipes was described from Iowa, and this is still the farthest eastern record. The summary of its distribution given by Marsh (1929) included records from only a few other states (Nebraska, Colorado, Texas). Since then, other records have extended or amplified its distribution: Oklahoma (Duck, 1937), Kansas (Leonard and Ponder, 1949; Ratzlaff, 1952); Texas and northern Mexico (Comita, 1951); Arizona, New Mexico, Montana (Kincaid, 1953); eastern Texas (M. S. Wilson, 1954).

The Light accession in the United States National Museum contains several collections of *clavipes* which further amplify its occurrence in southwestern United States and Mexico. These were all identified by Dr. Light, but have been verified in connection with the present study. The data with collections and associated calanoid species are as follows: *Arizona:* Small dammed reservoir in edge of hills, one mile south of Payson, Gila Co., May, 1935, S. F. Light, elevation 4800 feet; Coolidge Dam, San Carlos Lake, Gila Co., May, 1935, S. F. Light, elevation 2400 feet, with *D. siciloides;* Annex Lake, Coconimo National Forest, Coconimo Co., May 26, 1934, S. Wright, with *D. nudus;* About 10 miles north of Williams, Coconimo Co., May 15, 1937, A. Michelbacher, elevation 6690 feet, with *D. nudus*.

Nevada: Mead Lake, in deep water above dam, Clark Co., April, 1937, A. Michelbacher, with *D. siciloides. New Mexico:* A prairie lake near Clovis, Curry Co., July, 1941, Kathryn Buchanan, with *D. siciloides;* Another lake, same data, with *D.* (*Mastigodiaptomus*) *albuquerquensis. Texas:* Small artificial lake at Baird, Callahan Co., July, 1936, S. Wright, with *D. siciloides. Mexico:* Tank, 20 miles northeast of Cumondu, Baja California, July 21, 1938, A. Michelbacher and E. Ross, with *D. novamexicanus;* Presa de Hipolito, Coahuila, May 11, 1941, E. S. Deevey, with *D. siciloides.*

The common diaptomid association in these instances is with a species of the subgenus *Leptodiaptomus.* Such is also true in the occurrence of *clavipoides* with *D.* (*L.*) *moorei.* This latter species was also found in eastern Texas with *clavipes* (M. S. Wilson, 1954).

In present knowledge, therefore, the distribution pattern of *clavipes* includes the lower altitudes of the Rocky Mountains in the United States and neighboring areas of northern Mexico, the nearby south-

western states and those east to the Mississippi River. Its most western occurrence is in Baja California, Mexico. At present there are no known records from the state of California. The Nevada record given above is on the border of Arizona. Whether the species is generally spread in the western Mississippi Valley is still to be investigated. It can not be called a rare species, and its occurrence at widely ranging altitudes and in diverse bodies of water, such as lakes, reservoirs, ponds and roadside ditches, suggests both a much more common occurrence than now recorded and in part, at least, a fortuitous type of dispersal.

The comparative distribution patterns and associations of closely related species of diaptomids have been little considered in North America. We do not actually know what significance attaches to geographic distribution in relation to the taxonomy of diaptomid copepods. As a result of my studies, I have come to the conclusion that it may well be a very useful tool in the interpretation of taxonomy both in relation to the status of forms and the evaluation of characters. Of particular importance is the study of closely allied species (M. S. Wilson, 1953: 2). When thoroughly known, the comparative distribution patterns, associations and characters of these two aglaodiaptomid species may be of instructive value in the taxonomy of the group. Quite possibly, the two may be macrogeographically sympatric in the lower western Mississippi Valley and westward into Texas. This is already suggested by the presently known distribution of *clavipes* and the association of both species with *D. moorei* within a rather close geographic range as represented by the eastern Texas record of *clavipes* and the type locality of *clavipoides* in western Louisiana. The distribution of the latter species may be more localized or restricted than that of *clavipes,* but no conclusions on the presence or absence of either species can be reached until the region involved has been thoroughly surveyed.

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